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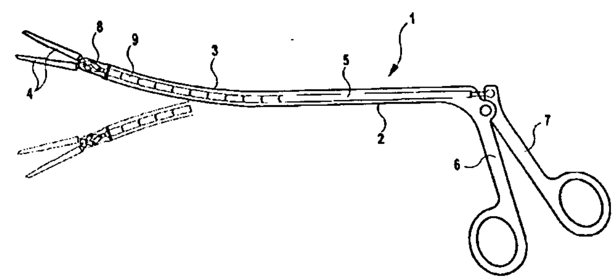
(54) Surgical Tubular Shafted Instrument

(57) Surgical tubular shafted instrument having a tube-shaped flexible shaft and having a longitudinally moveable and flexible force transfer element housed therein, wherein the force transfer element (5) is comprised of a plurality of individual sections (9) that are arranged one after another contacting the inner wall of the shaft (2) and that have a ball-joint-like connection (10, 13) in the area in which two individual sections (9) contact each other.



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SURGICAL TUBULAR SHAFTED INSTRUMENT

The invention relates to a surgical tubular shafted instrument having a tubular flexible shaft and a longitudinally moveable and flexible force transfer element housed therein.

An instrument of this type is described, for example, in DE 195 20 717 C2.

A thrust and tension rod guided inside the shaft has its diameter reduced in some areas in this prior-art design, so that a bend is possible in this area, while in other areas in which the diameter is not reduced, the thrust and tension rod contacts the inside of the shaft and is thereby prevented from bending. Of course, with this design it is not possible to transfer very high compressive loads if the inflection points that have a large diameter are located far from each other; and if they lie very close to each other, the flexibility is limited.

The object of the present invention is to configure a shafted instrument of the claimed type so that it is possible to transfer high compressive loads while maintaining high flexibility.

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This object is accomplished by a surgical tubular shafted instrument of the type described above in an inventive manner wherein the force transfer element is comprised of a plurality of individual sections that are arranged one after another contacting the inner wall of the shaft and that have a ball-joint-like connection in the area where two individual sections contact each other. This relatively large number of individual sections therefore permits the force transfer element to be pivoted at the ball-joint-shaped connection points in any given direction, so that the force transfer element overall has a high flexibility, while at the same time, however, the entire cross section of the shaft is used in order to be able to transfer compressive loads in this area; a lateral deflection of the individual sections is not possible, and the compressive loads can be transferred reliably to the adjacent individual section via the ball joint.

In a preferred embodiment, for example, an individual section in the area of contact with the adjacent individual section has a spherical bearing pan, and the adjacent individual section then has a spherically projecting bearing surface that projects into the bearing pan. The bearing pan can be closed, and the spherically projecting bearing surface can also be closed, so that the entire bearing surface is available for the force transfer.

The rim of the bearing pan can surround the adjacent individual section with an elastic detenting or snap-in connection, so that the two adjacent individual sections can be plugged together in this way in the axial direction; one then obtains a relatively long force transfer member made of individual sections that are all held together by the detent connection and can pivot relative to

each other, whereby, of course, the pivotability does require any relatively large angular change for each individual ball joint in order, nevertheless, to achieve adequate flexibility for the entire force transfer element.

In another embodiment, the bearing pan is formed by an annular bearing surface having an arcuate contour on the inner wall of the individual section, which is designed in the shape of a tube piece. The spherical bearing surface of the adjacent individual section therefore extends into the interior of the first individual section and is guided in this annular bearing surface, which has an arcuate contour. The compressive loads can also be transferred in this area.

Here, it is possible for the individual sections in the area of the annular bearing surface to be divided into tabs located adjacent to each other in the circumferential direction by means of slits, with the elastic tabs preferably being able to flex elastically toward the outside. An elastic snap-in or detent-type connection can also be implemented in this manner.

In particular, the described force transfer element is especially well suited for transferring compressive loads. However, it is also possible to route a flexible tension element through the individual sections. This tension element is then utilized in the form of a thin flexible rod or a cable. In this case the force transfer element is also well suited for transferring tension loads.

The tension element can be guided through a central opening in each individual section.

In a preferred embodiment, the individual sections are curved in a concave shape in the longitudinal direction between their ends. The curvature is preferably selected in such a way that it corresponds to the curvature of the inner side of the shaft upon maximum flexing of the shaft. In this case, the shaft can abut against the outer contour of the individual sections, so that the individual sections receive additional guidance. Moreover, this defines a maximally curved configuration.

In a preferred embodiment, the individual sections can be enclosed by a common flexible tube or by a plastic jacket that is pulled over the individual sections, or that is molded around these sections.

The described shafted instrument can, in particular, be constructed in such a way that the shaft is inserted into a handle part and in the inserted position is secured by a releasable latching means in the handle part. This allows the shaft to be removed from the handle part, thereby providing improved possibilities for cleaning; in addition, different shafts can be used with the same handle part.

In a preferred embodiment, the latching means may have a spring-loaded pivot lever which in a latched position secures the shaft and prevents axial movement by means of the engagement of a projection in a recess. This results in a very

easy-to-operate latching means that permits the shaft to be released solely by operating the spring-loaded pivot lever.

It is advantageous for the shaft to be prevented from rotating about its longitudinal axis when it is in the position in which it is inserted into the handle part.

The force transfer element may additionally be removeably connected to an actuating means at its end facing the handle part. This also allows separation to occur in the handle part area; if necessary, the shaft and the force transfer element can both be separated together from the handle part and the actuating means located there.

It is particularly advantageous when the removable connection is formed by a push-in coupling which, when the force transfer element is pushed into the push-in coupling, initially does not have a connection to the actuating means and a connection is not established until the force transfer element is pushed in further. The connection is established by the insertion movement itself, and no additional coupling operations are necessary. Conversely, this connection can be disengaged solely by pulling the force transfer element out of the push-in coupling.

For example, the push-in coupling may comprise a driver with an open notch on one side into which a projection of the force transfer element can be inserted.

Especially preferred is the design in which the driver together with the notch is positioned to pivot in the handle part between an insertion position in which the

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projection of the force transfer element can enter the open end of the notch upon insertion into the handle part and a coupling position in which the notch essentially extends in a transverse direction relative to the direction in which the force transfer element moves. Thus, in this design the projection can enter the notch in the inserted position without any difficulty, but not in the coupling direction, which essentially extends transverse thereto.

It is possible for the driver to be pivoted by the actuating device and thereby in this coupling position to move the force transfer element axially by means of the projection that engages the notch. Thus, the driver not only serves to couple the force transfer element to the actuation means, but also to transfer movement from the actuation means to the force transfer element. For example, the driver can itself be part of a pivotable handle piece of the handle part.

It is particularly advantageous if, when the force transfer element is inserted at an angle relative to the direction in which the force transfer element moves, the force transfer element pivots the driver when the element is pushed further into the coupling position.

It is also advantageous when the driver is pivoted by a spring into the insertion position; in particular, this spring may be a form spring, which is held on the pivot lever that prevents the shaft from moving axially.

In a preferred embodiment, the force transfer element can be connected to the tool at its end facing the tool by means of a releasable bayonet coupling, whereby a transfer member that connects the force transfer element to the actual tool per se can also be understood to fall under the scope of the term "tool."

It is preferable that the tool have a receiving recess for the end of the force transfer element; in particular, the end of the force transfer element and the receiver may have a conical design.

The bayonet latching may, in a preferred embodiment, be accomplished by axially bringing together the force transfer element and the tool, and then by rotating the two parts in opposing directions about the longitudinal axis of the force transfer element.

The tool preferably has a latching projection that projects in the direction of the force transfer element and that is located in an L-shaped channel in the force transfer element.

The ability to disconnect the shaft and/or the force transfer element from the handle part and the ability to connect the force transfer element to the handle part and the ability to connect the force transfer element to the tool may be advantageous in a surgical tubular shafted instrument having a flexible shaft and a flexible force transfer element; however, as a general rule this use can also occur with other types of tubular shafted instruments. Intellectual property protection can therefore also extend to tubular shafted instruments having

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embodiments that do not have a flexible shaft and do not have a flexible force transfer element, and rather are designed in some other way.

The following description of preferred embodiments of the invention is for purposes of further illustration and is used in conjunction with the drawing. The drawing shows:

Figure 1: a side view of a forceps- or scissors-shaped tubular shafted instrument having a flexible shaft;

Figure 2: a longitudinal cross-sectional view through the flexible area of the shaft;

Figure 3: a schematic diagram of two elastically plugged-together individual sections of the force transfer element having a tension element extending through said sections;

Figure 4: a side view of a different preferred embodiment of a tubular shafted instrument having the ability to separate the shaft and the force transfer element from the handle part and having a detachable connection between the force transfer element and the tool;

Figure 5: an enlarged detail view of the bearing area of the shaft in the handle part with the instrument of Figure 4 and with the shaft latched and with the force transfer element connected;

Figure 6: a view similar to that shown in Figure 5 with the shaft disconnected and the force transfer element disconnected;

Figure 7: an enlarged detailed view of the connection area between the force transfer element and the tool;

Figure 8: a top view of the instrument of Figure 7.

The invention is explained on the basis of a forceps- or scissors-shaped tubular shafted instrument; however, it is to be understood that the invention may be used with all tubular shafted instruments in which a force transfer element is guided on the inside of the shaft and that transfers a movement from the proximal end to the distal end through the shaft.

The tubular shafted instrument 1 shown in the drawing has a longitudinal, tubular shaft 2 that is embodied to be flexible, at least in its distal area 3. In a manner that is already known per se, this shaft can be made of plastic material or it can be a thin-walled metal tube that is flexible within certain limits.

Working elements 4 that can be moved in opposition to each other are disposed at the distal end of the shaft 2. For example, the working elements 4 can be two clamping jaws that pivot in opposition to each other or two blades of a scissors that pivot in opposition to each other. In order to move these working elements, a flexible force transfer element 5 that passes all the way through this shaft 2 is disposed in the inside of the shaft 2; at the proximal end of the shaft 2, the force transfer element 5 projects out of said shaft 2. In this area the shaft 2 is rigidly

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connected to a handle piece 6, on which a second handle piece 7 is mounted in a pivotable manner. The force transfer element 5 is driven on this second handle piece 7, so that when the handle piece 7 is pivoted relative to handle piece 6, the force transfer element 5 is moved in the longitudinal direction relative to shaft 2. This movement of the force transfer element 5 is translated in the distal area by suitable drive elements into a pivoting movement of the working elements 4; in the example of the embodiment shown, bell crank connections 8 are provided to translate the longitudinal movement into a pivoting movement.

The force transfer element 5 is, at least in its flexible portion, constructed of individual sections 9 that abut each other in a force-fitting manner in the longitudinal direction of the force transfer element 5. In the example of the embodiment shown, each individual section 9 is designed as a tubular piece that is terminated at its distal end by a spherical face surface 10, which has a peripheral angle of more than 180 degrees. On the opposing side, each individual section 9 is divided into a plurality of tabs 12 by means of axially parallel cuts; these tabs 12 are provided on their inner side with an annular bearing surface 13 that has an arcuate contour and that extends around the circumference. The tabs 12 can deform elastically to a slight extent toward the outside direction; so that two adjacent individual sections 9 can also be connected to each other, so that an individual section 9 at the spherical face surface 10 can be inserted into the open end of the other individual section 9, and in this process the tabs 12 are elastically flexed open, and the spherical face surface 10 automatically engages the annular bearing surface 13 in an elastic manner. In this way, a spherical ball-shaped connection between adjacent

individual sections 9 is obtained, which ensures that the adjacent individual sections 9 can pivot relative to each other to a certain extent in all directions; at the same time, however, a transfer of force in the axial direction can be prevented, since the tabs 12 are prevented from moving in a radially outward direction after the force transfer element has been inserted into the shaft 2.

In addition, the individual sections 9 can be configured as spherical pans at their sides that are opposite the spherical face surface; in this case, the annular bearing surface 13 would be continued in a bearing pan that extends over the entire cross section.

A flexible tension member 14, which can be configured, for example, as a thin flexible rod or as a cable, passes through the central openings in the spherical face surface 10, so that compressive loads can be transferred optimally through the contact of the spherical bearing surfaces with each other by means of the force transfer member 5, while tensile loads can be transferred optimally by the tension member 14.

Each individual section 9 is constricted slightly in a concave configuration in the longitudinal direction between its two ends; the contour of this necking is selected to be essentially arcuate, and its curvature corresponds to the smallest curvature that occurs on the interior of the shaft 2 when the shaft 2 is completely curved. In this case, the shaft 2 can contact the outer side of the individual sections; this results in an optimal mutual bracing effect when compressive loads are being transferred, and it also limits the flexibility of the entire shaft arrangement.

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The entire arrangement is very easy to assemble, and it is also easy to disassemble for cleaning purposes; all that is needed is to remove the force transfer element 5 from the shaft. Then the individual sections 9 can easily be pulled apart and, finally, pushed back together. On the other hand, in the interior of the shaft 2 separation of the spherically connected individual sections is prevented by the fact that the tabs 12 cannot move radially outward.

The shaft 2, the force transfer element 5, and the handle pieces 6, 7 that comprise the handle part, can be detachably connected to each other; it is also possible to connect the force transfer element 5 in a detachable manner to one of the tools 4. Possible types of connections are described below in a further typical embodiment of a tubular shafted instrument, as described in Figures 4 to 8. The possibility of connecting the shaft and/or the force transfer element to the handle part and of connecting the force transfer element to the tool are not limited to the embodiment of a tube in the manner that was described on the basis of Figures 1 to 3. Rather, this embodiment can also be used in tubular shafted instruments in which the shaft and the force transfer element are embodied differently, for example if they are rigid.

Corresponding parts have the same reference numbers as those in the typical embodiment shown in Figures 1 to 3.

As with the typical embodiment shown in Figures 1 to 3, in the typical embodiment shown in Figures 4 to 8, two handle pieces 6, 7 are provided. One handle piece 6 can rigidly be connected to the shaft 2; however, in this case the

connection can be detached. For this purpose, the handle piece 6 has at its front end 20 an insertion opening 21 for the shaft 2. On the lower side of the insertion opening 21 a pin 22 fixed rigidly on the handle piece 6 projects a small distance into this insertion opening 21. This pin 22 extends into a slot 23 on the shaft 2 when the shaft 2 is pushed into the insertion opening, thus providing a means to prevent rotation. Moreover, at the end of the slot 23, the pin 22 limits the depth to which the shaft 2 can be inserted into the insertion opening 21.

On the side that faces the slot 23, the shaft 2 has a recess 24, which, for example, can be formed by a rectangular opening in the wall of the shaft or by a cut.

This recess 24 is arranged in such a way that when the shaft 2 is fully inserted, a projection 25 of a catch 26 engages in this recess 24, thereby securing the shaft 2 in the axial direction. This catch 26 is pivotably mounted in a larger cavity 27 into which the insertion opening 21 opens; the pivot axis extends in parallel to the pivot axis of the two handle pieces 6, 7; and it lies approximately in the center of the catch 26. If one therefore presses on the back part of the catch 26, the projection 25 disposed on the front side of the catch lifts out of the recess 24 in the shaft 2, releasing the shaft 2; conversely, if the projection 25 drops down into the recess 24 when the catch 26 is not pressed down, the catch 26 is held in this latched position by means of a clock shape spring 28. The shape spring is inserted into a slit 29 in the catch 26.

The end of the shaft 2 facing catch 26 is chamfered, so that when the shaft 2 is pushed through the insertion opening 21, the catch 26 is lifted by the chamfered end of the shaft 2 in opposition to the force exhibited by the shape spring 28, until the shaft 2 is pushed so far into the insertion opening 21 that the projection 25 can enter the recess 24, thereby securing the shaft axially.

A coil spring 31 is inserted into a blind hole 30 of the catch 26. This coil spring 31 is supported on a support surface 22 of the handle piece 6, in this way preventing the catch 26 from unintentionally being pressed. Only when a given compressive load is exceeded can the catch 26 be pivoted in the direction that causes the shaft 2 to be released.

The other handle piece 7 is mounted in a pivoting manner on handle piece 6 in the area of the recess 27, and it terminates above the pivot axis in a driver 33 in which at the free end an open notch 34, whose width widens slightly toward the open end, is disposed.

The driver may be designed as a fork having two wall parts that extend parallel to each other, each having their own notch 34; such a wall part may be configured such that it is only located on one side of the driver 33.

The force transfer element 5 extends on the back side from shaft 2, and there it has a coupling piece 35 with a laterally offset driving pin 36, which, in the assembled condition, engages the slots 34 of the driver 33 thereby producing a rotational connection which, when the handle piece of the force transfer

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element 5 is pivoted in shaft 2, can be moved forward and backward (Figure 5). The driver 33 is pivoted in a coupling area in which the coupling is permanently maintained. The dimensions are selected in such a way that the handle pieces 6 and 7 cannot be placed right up next to each other when the tool is closed. Instead, the closure movement is terminated when the tools are close to each other, so that a clearance is maintained between handle pieces 6 and 7.

If the shaft 2 is pulled out in the forward direction from the handle piece 6 after the catch 26 has been released, this automatically also results in a pivoting of the driver 33 and thus of the handle piece 7, since the shaft 2 also pushes the force transfer element 5 forward, and the driver is pivoted forward. This pivoting proceeds so far as to permit moving the engaging pin 36 from the notch 34 on the driver 33 in a forward direction (Figure 6), so that both the shaft 2 as well as the force transfer element 5 can be pulled clear from the handle piece 6.

The shape spring 28 is supported at the driver 33 in such a way that the driver 33 is pivoted into the front pivot position, and so that, when the shaft 2 is pulled out and when the force transfer element 5 is pulled out, the notch remains in the position that it assumed when the force transfer element was pulled out. On the other hand, when the force transfer element 5 is once again inserted, it is possible for the engagement pins 36 to enter the slot 34 and, in the case of impact on the side wall of the slot 34 and further insertion of the driver 33 in

opposition to the curvature of the shape spring 28 to move into the coupling position, in which it is no longer possible to pull out the driving pin (36) in the direction in which the force transfer element 5 moves.

In general, in this manner one obtains a very easy way to connect the shaft as well as the force transfer element to the fixed handle piece, and then to disconnect these parts from each other again. Upon insertion, the driver pins 36 automatically enter the notch 34, pivoting the driver 33 into the coupling position and, thus, into the working position per se; at the same time, the chamfered end of the shaft 2 pivots the catch 26 into the open position, so that the rear end of the shaft 2 can slide past the projection 25 until the projection enters the recess 24, thus securing the shaft 2 as well as the force transfer element 5 in the radial direction. After this the shaft 2 can no longer move in the axial direction, the force transfer element 5 can only move to a limited extent corresponding to the pivot movement of the driver 33.

To disconnect, all that is needed is to press the catch 26. Then the shaft 2 and the force transfer element 5 can easily be pulled out of the handle piece 6 from the front.

To connect the force transfer element 5 to a working element 4, said working element 4 must have a central receiving hole 37 that narrows slightly in a conical manner into which a complementary end 38 of the force transfer element can be inserted. At this end 38 of the force transfer element 5 and L-shaped guide channel 39 is provided. This guide channel 39 first extends parallel to the axis

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from the front end and then turns at a right angle and, as a whole, is therefore L-shaped. When the end 38 is inserted into the receiving hole 37, a pin 40 that projects slightly inward into the receiving hole 37 enters this guide channel 39. This pin is, for example, a screwed-in stud screw, and upon insertion it first travels in the portion of the guide channel 39 that is parallel to the axis. When the end of this portion of the guide channel that is parallel to the axis is reached, the end 38 and the working element 4 are rotated relative to each other about the longitudinal axis of the force transfer element 5, which causes the pin 40 to enter the portion of the guide channel 39 that is oriented in the circumferential direction. This secures the end 38 axially in the receiving hole 37, thus producing a lasting effective connection between the force transfer element 5 and the working element 4. The parts can be detached in the reverse manner.

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WHAT IS CLAIMED IS

1. A surgical tubular shafted instrument having a tubular flexible shaft and a longitudinally moveable and flexible force transfer element housed therein, wherein the force transfer element (5) is comprised of a plurality of individual sections (9) that, contacting the inner wall of the shaft (2), are disposed in a row and in the area where two individual sections (9) come in contact have a ball-joint-like connection (10, 13).

2. The surgical tubular shafted instrument of Claim 1, wherein an individual section (9) in the area of contact with the adjoining individual section (9) has a spherical bearing pan (13), and the adjacent individual section (9) has a spherically projecting bearing surface (10) that extends into the bearing pan (13).

3. The surgical tubular shafted instrument of Claim 2, wherein the margin of the bearing pan (13) encloses the adjacent individual section (9) with an elastic detent-type or snap-in connection.

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4. The surgical tubular shafted instrument of one of the above claims, wherein a flexible tension element (14) is passed through the individual sections (9).

5. The surgical tubular shafted instrument of Claim 4, wherein a tension element (14) is a thin flexible rod or a cable.

6. The surgical tubular shafted instrument of Claims 4 or 5, wherein the tension element (14) is passed through a central opening in each individual section (9).

7. The surgical tubular shafted instrument of one of the above claims, wherein the individual sections (9) are curved in a concave shape in the longitudinal direction between their ends.

8. The surgical tubular shafted instrument of Claim 7, wherein the curvature corresponds to the curvature at the maximum flexure of the shaft (2) on the inner side of the shaft (2).

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9. The surgical tubular shafted instrument of one of the above claims, wherein the individual sections (9) are enclosed by a common flexible tube or plastic jacket.

10. The surgical tubular shafted instrument of one of the above claims, wherein the bearing pan is formed by an annular bearing surface (13) having an arcuate contour on the inner jacket of the tube section-shaped individual section (9).

11. The surgical tubular shafted instrument of Claim 10, wherein the individual section (9) is divided in the area of the annular bearing surface (13) by cuts (11) into tabs (12) that are adjacent to each other in the circumferential direction.

12. The surgical tubular shafted instrument of Claim 11, wherein the tabs (12) can flex elastically in the outward direction.

13. The surgical shafted instrument of one of the above claims, wherein the shaft (2) is inserted into a handle part (6) and is secured in the inserted position by a detachable latching means (24, 25, 26) in the handle part (6).

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14. The surgical tubular shafted instrument of Claim 13, wherein the latching means has a spring-loaded pivot lever (26) that in the locked position prevents the shaft (2) from moving axially by the engagement of a projection (25) into a recess (25).

15. The surgical tubular shafted instrument of Claim 13 or 14, wherein the shaft (2) is prevented from rotating about its longitudinal axis in its position inserted into the handle part (6).

16. The surgical tubular shafted instrument of one of Claims 13 to 15, wherein the force transfer element (5) is connected in a detachable manner on its end facing the handle to an actuating means (7, 33).

17. The surgical tubular shafted instrument of Claim 16, wherein the detachable connection is formed by a push-in coupling (33, 34, 35, 36) which, when the force transfer element (5) is pushed into the push-in coupling, initially does

not have any connection to the actuating means and does not establish a connection until the force transfer element (5) is pushed in further.

18. The surgical tubular shafted instrument of Claim 17, wherein the push-in coupling comprises a driver (33) having a notch (34) that is open on one side into which a projection (36) of the force transfer element (5) can be inserted.

19. The surgical tubular shafted instrument of Claim 18, wherein the driver (13) is mounted so that it is able to pivot on the handle part (6) between an insertion position, in which the projection (36) of the force transfer element (5) can enter the open end of the notch (34) when it is pushed into the handle part (6), and a coupling position, in which the notch (34) extends in a direction that is essentially transverse to the direction of movement of the force transfer element (5).

20. The surgical tubular shafted instrument of Claim 19, wherein the driver (33) can be pivoted by the actuating means (7), and in its coupling position it axially moves the force transfer element (5) over the projection (36) that engages the notch (34).

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21. The surgical tubular shafted instrument of one of Claims 19 or 20, wherein when the force transfer element (5) is inserted, the driver (33) is located in the position that is inclined relative to the direction in which the force transfer element (5) moves such that the force transfer element (5) pivots the driver (33) into the coupling position when it is inserted further.

22. The surgical tubular shafted instrument of one of Claims 19 to 21, wherein the driver (33) is pivoted by a spring (28) into the insertion position.

23. The surgical tubular shafted instrument of Claim 22, wherein the spring (23) is a shape spring that is held on the pivot lever (26) and that secures the shaft (2) against axial movement.

24. The surgical tubular shafted instrument of one of the above claims, wherein the force transfer element (5) is connected to a tool (4) at its end facing the tool (38) by means of a disconnectable bayonet coupling (39, 40).

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25. The surgical tubular shafted instrument of Claim 24, wherein the tool has a receiving recess (37) for the end (38) of the force transfer element (5).

26. The surgical tubular shafted instrument of Claim 25, wherein the end (38) of the force transfer element (5) and the receiver (37) have a conical shape.

27. The surgical tubular shafted instrument of one of Claims 24 to 26, wherein bayonet latching is accomplished by axially bringing together the force transfer element (5) and the tool (4) and by subsequently rotating the two parts (4, 5) in opposite directions relative to each about the longitudinal axis of the force transfer element (5).

28. The surgical tubular shafted instrument of Claim 27, wherein the tool (4) has a latching projection that projects in the direction of the force transfer element (5) and that is guided in an L-shaped channel (30) of the force transfer element (5).

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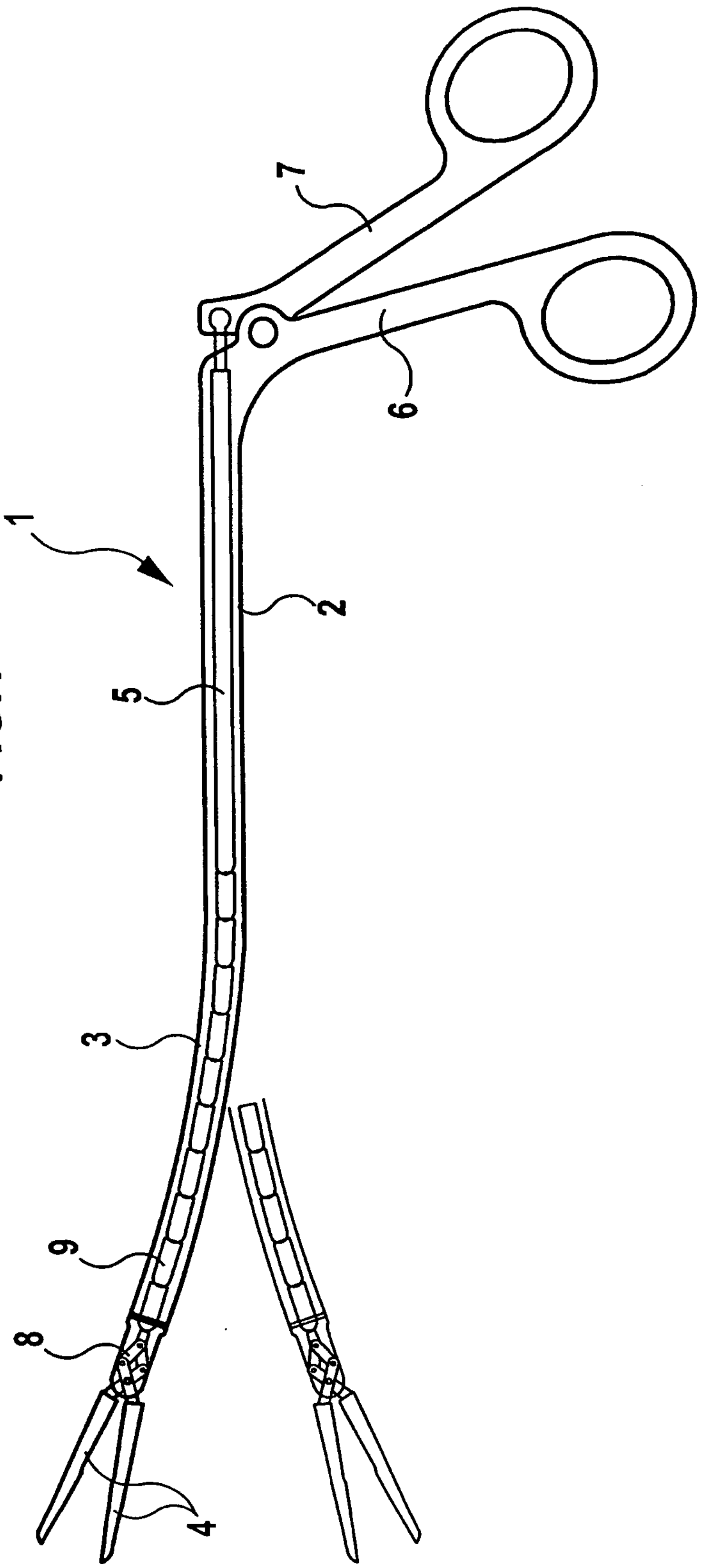
FIG.1



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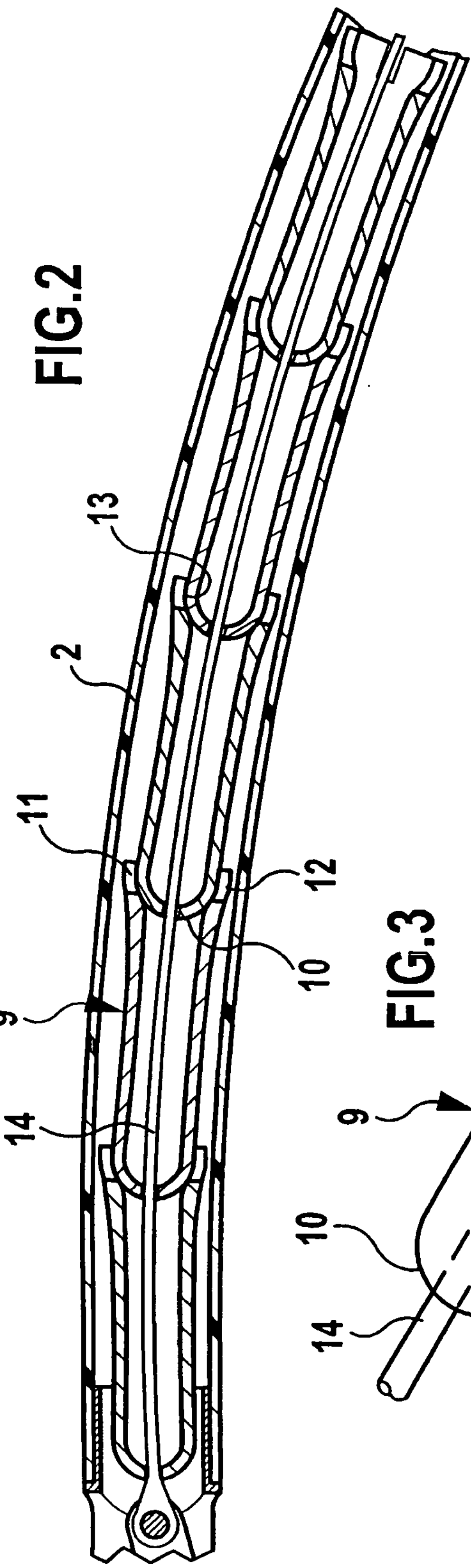

FIG.2

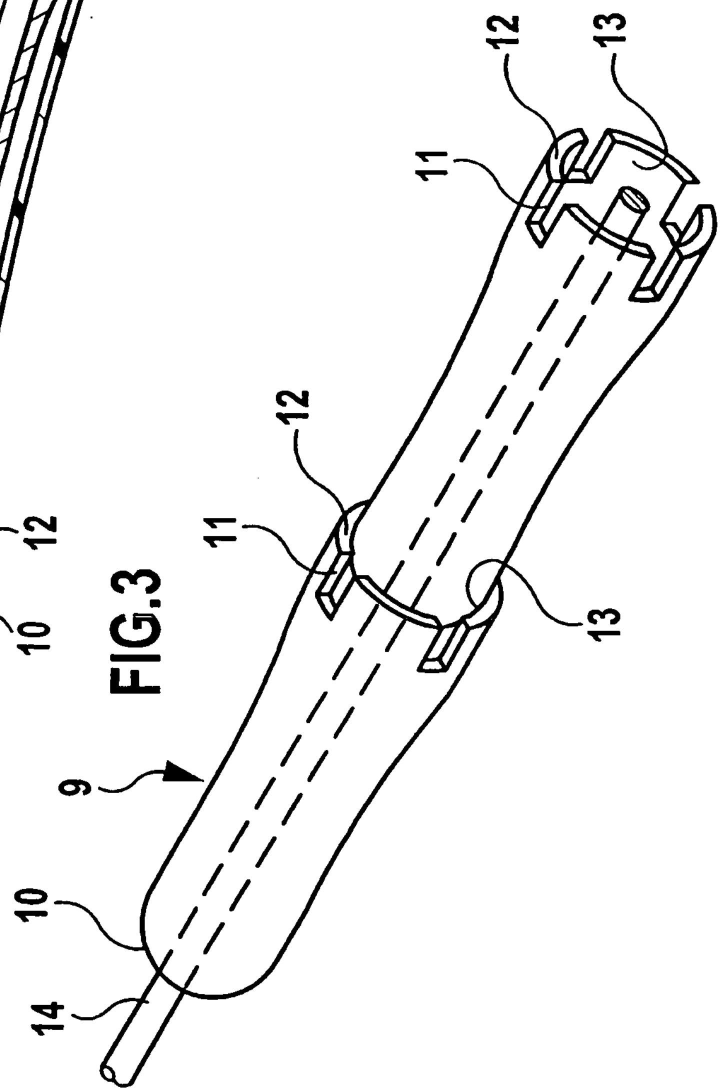

FIG.3

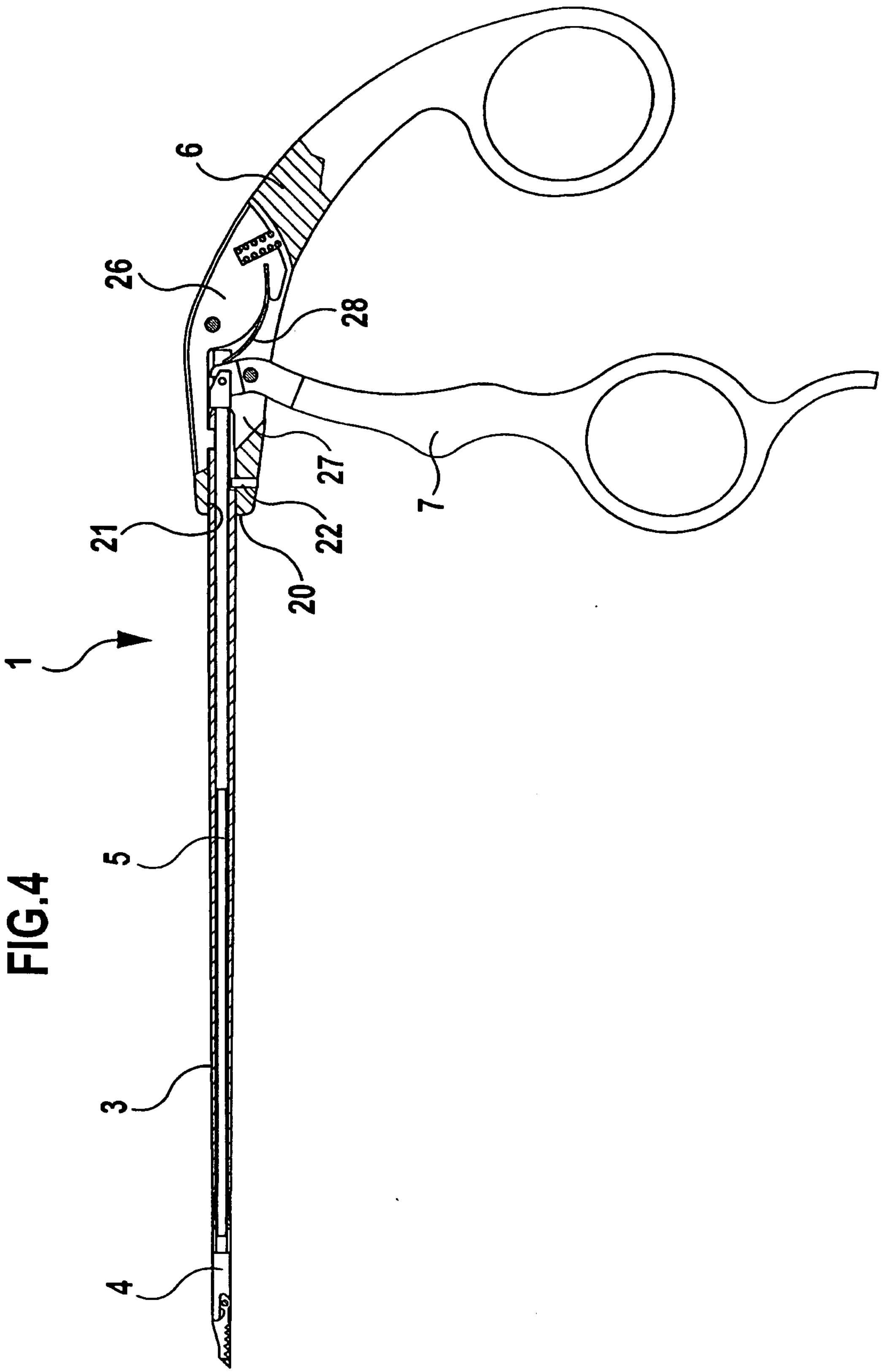

FIG.4

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FIG.5

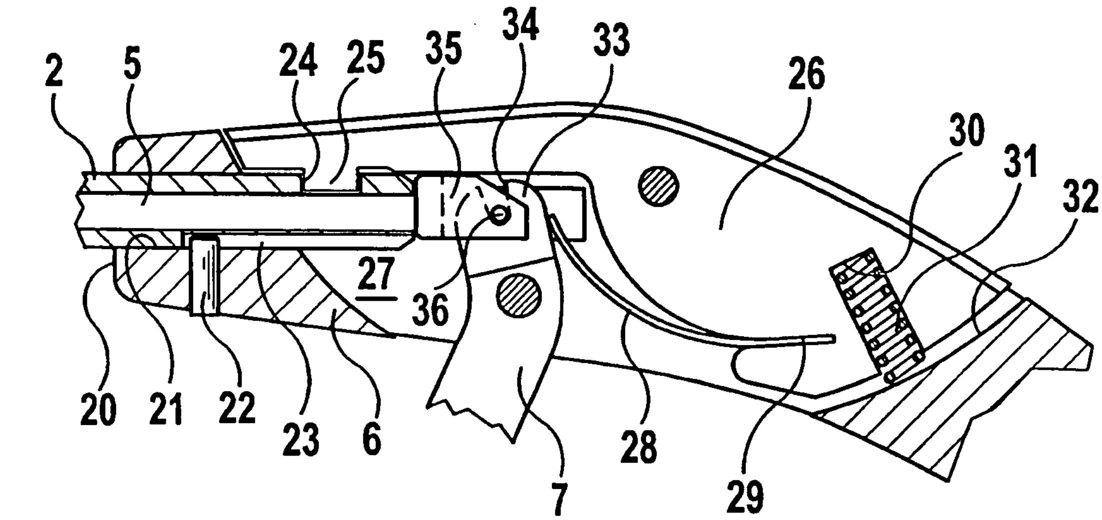
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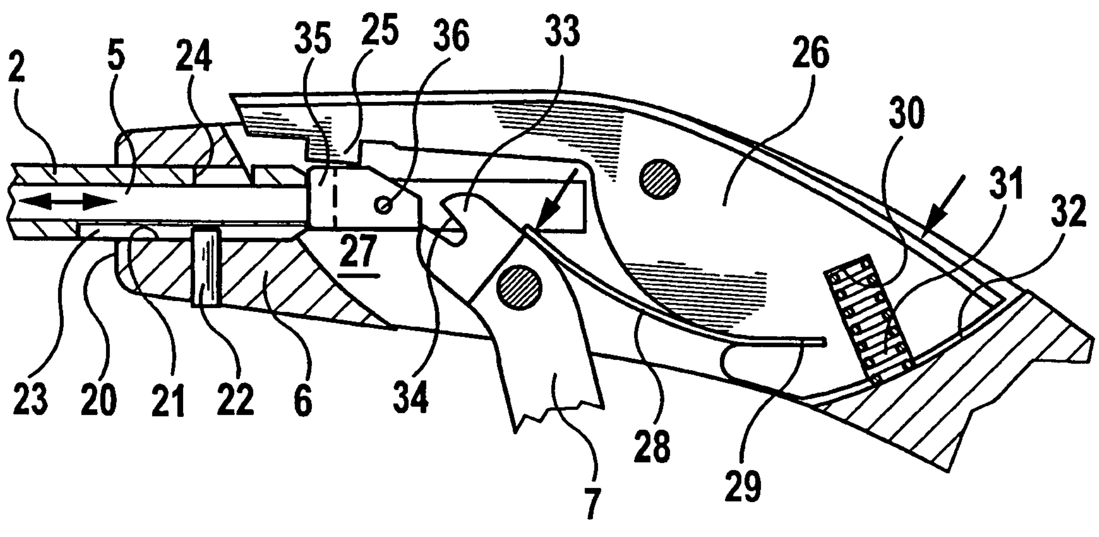
FIG.6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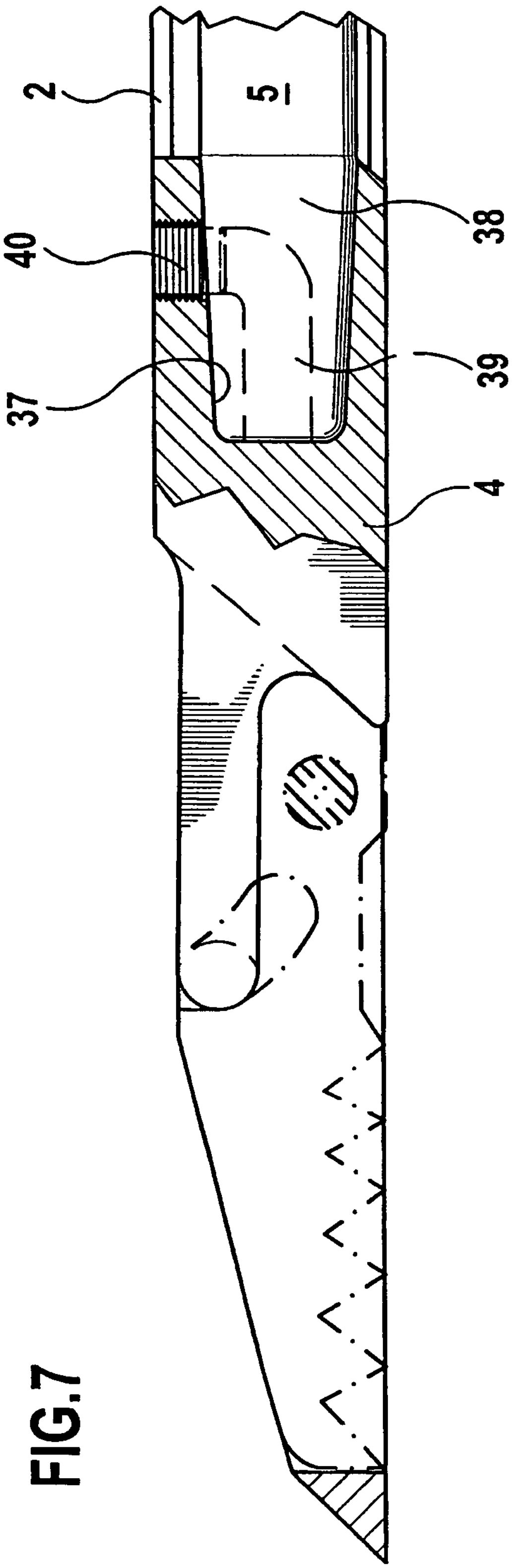

FIG.7

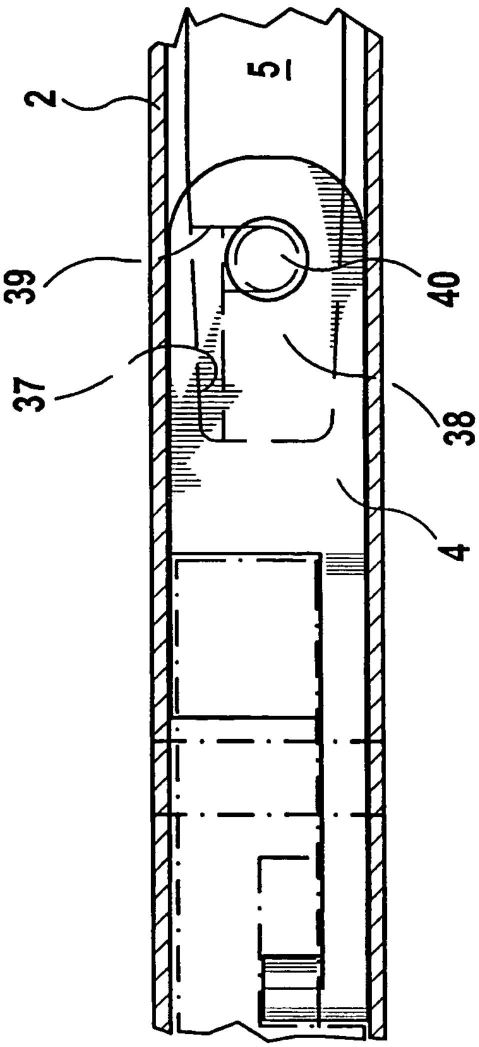

FIG.8